Let us now revert to our leading question in order to see how it looks in the light of the facts we have been examining. That question was, you will recall, How nearly perfect is the adaptation of the activities connected with food gathering and storing by the California woodpecker? If the facts are really as presented no one can, I think, fail to see that none of the adaptations are perfect and that some of them are so imperfect that they are apt to result in serious injury or even death to the birds.

So here these "Further Observations" must end. One is terribly tempted to plunge into a flood of inquiry as to what such facts about the lives of woodpeckers may mean for the lives of men. But, of course, when such a plunge would involve pulling with one an entire company of his fellow beings, he must forbear. Forbearance can not, however, restrain me from saying this much as my positively last ending:

The only possible way of correcting imperfections in adaptations of the sort we have been considering, is through what we name intelligence. And this is equivalent to saying that *Nature's way of reducing to a minimum the inefficiency, the wastefulness, and the dangers involved in all living nature is what has been given the name Intelligence.* Such is the central thesis of my psycho-biological philosophy.

Scripps Institution for Biological Research, La Jolla, California, March 23, 1922.

FOSSIL BIRDS FROM THE PLEISTOCENE OF McKITTRICK, CALIFORNNIA

By LOYE MILLER

IT HAS been my good fortune and a great pleasure the past winter, to cooperate with mammalian Palaeontologists in the exploration at McKittrick, California, of a new exposure of Pleistocene asphalt comparable in nature, if not in extent, with the renowned Rancho La Brea beds of Los Angeles. Merriam and Stock (Science, n. s., LIV, p. 566, Dec. 9, 1921), have published a brief note upon these beds, enumerating the more characteristic mammal remains that have come to light in a brief reconnaissance. At the invitation of Dr. Stock, under whose direct supervision the work is going on, I spent a brief time with his field party from the Museum of Palaeontology and have undertaken the study of the avian remains excavated. This preliminary note is offered to CONDOR readers because of the live interest they have taken in the work at Rancho La Brea and the right good service that many Cooper Club members have rendered in contributing comparative material. All specimens taken out are deposited in the Museum of Palaeontology of the University of California at Berkeley.

The most casual inspection of the three hundred thirty odd specimens of McKittrick birds now on hand brings out some marked differences between this assemblage and those from other western horizons. To determine the underlying forces that have brought about these differences constitutes the present problem.

Perhaps the most striking feature that was brought out in the study of the Rancho La Brea birds some years ago was the great abundance, both in species and in individuals, of its raptors, many of which were of large size. Three condors, two smaller cathartids, two Old World vultures, a caracara, and the great *Teratornis* made up the contingent of scavenging raptors. Six eagles, three buteonines, three falcons, the marsh hawk, and the white-tailed kite, represented the active predators by day, while a night shift of six species of owls continued the predatory work after sunset. More than half the total bird remains taken from these beds came from birds of the orders of raptorial habit—a most unusual situation indeed.

The collection from McKittrick is admittedly a limited one, yet it is sufficient to show the totally different proportions of its fauna. The golden eagle (*Aquila chrysaëtos*) is the only raptor represented by more than one or two specimens, but of this lusty fellow there appear some ninety determinable bones. *Polyborus* (sp.) is the next raptor in point of numbers, with seven bones; the little *Falco sparverius* follows with four; and *Circus hudsonius*, *Falco peregrinus*, *Geranoaëtus* (?), *Cathartes* (?), and *Teratornis*, with one specimen each. In contrast with this limited predatory population, the water birds, so scarce at Rancho La Brea, constitute more than two-thirds of the determinable remains thus far taken from the new horizon. Anserines, ranging in size from a teal to a goose, are in the majority, being represented by 33% of the whole collection. Limicolines follow in order with 20%, whereas at Rancho La Brea they number less than one in ten thousand. Two large storks resembling *Ciconia maltha* and *Jabiru mycteria* are present in numbers approaching 15%, while herons and cranes are well represented.

The order of the scratchers has contributed to the collection thus far but a single bone, the coracoid of a quail indistinguishable from the present bird of the region, *Lophortyx californica*. Rancho La Brea, though equally poor in quail remains, is abundantly rich in the big *Parapavo*, as yet undiscovered in the McKittrick. The two localities agree in the total absence of all the gull tribe, as well as in the great scarcity or entire absence of all sorts of diving birds, a matter of considerable interest in view of the abundant ducks and geese.

While the collections from McKittrick are admittedly meager as yet, they are, nevertheless, very strongly indicative of topographic differences that must have existed between the locality and that of Rancho La Brea at the time of entombment of the bird remains. The indicated contrast lies in the different amounts of open water and of cover offered as attractions to them.

At Rancho La Brea, the great abundance of *Parapavo* strongly suggests a considerable amount of timber, at least in spots. There are, to be sure, osteologic differences between this bird and its present-day relatives, sufficient to admit of great diversity of habit, yet *Parapavo* could scarcely have been a bird of the open plains. The presence of bedded leaves, of twigs, and even of goodly sized tree trunks further bears out this impression of cover, while the scarcity of anserines and the almost total absence of limicolines indicate the absence of shallow, open water in bodies of any great size. Water there was to be sure, but it might well have been in very narrow basins or in brushy seepage areas augmented during the rainy season into a slow-moving stream along the bed of a slight depression. Just such conditions, except for the absence of timber, prevail in the im-

mediate neighborhood of Rancho La Brea today. Moderate shift of drainage lines would readily produce, or as readily destroy, such thickets.

At McKittrick, quite a different picture presents inself to the imagination. Mud flats of some appreciable extent are the insistent demand which such a wader population would make upon our powers of reconstruction. These dabblers call for mud in quantity, spread out, free from thicket, and barely exposed above quiet waters. The anserine population makes a somewhat similar demand. To be sure, an occasional duck will drop down into the smallest of pools, but this goodly host of paddlers of all sizes certainly indicates open water somewhere in the near vicinity. Storks, herons, and cranes in force raise the water birds to a two-thirds majority (67%). Surely such a population could have been assembled only by the lure of open country. Conditions during the Pleistocene might well be considered to have been much like those now prevailing at Buena Vista Lake a few miles to the eastward of McKittrick.

The oil seepage which entrapped the birds may well be considered to have been located at or somewhat back from the margin of such a lake. The upheaval and subsequent erosion that resulted in the present location of the asphalt lens upon a hillside could easily have obliterated other evidences of the lake by removal of typical lacustrine deposits.

The other alternative to such a reconstruction, a view supported by the abundant remains of mud-gathering swallows, is that of an oil seepage accompanied by springs of fresh water discharged through vents of common origin with the oil. To such springs, in seasons of increased alkalinity of lake waters, many species of birds might repair for drink. Probably the hypothesis most nearly approximating the truth, however, is of a marginal seepage connected at least by slough or muddy runway with a lagoon of appreciable size.

The chief objection to this lacustrine reconstruction is the previously mentioned fact that remains of gulls and divers are entirely lacking. But may we not find some measure of reason for this discrepancy in the habits of these birds? Would not their habits offer a measure of immunity from the dangers of the oil-seepage that ducks and waders would not enjoy? They are birds of open water or sand bars, rather than dabblers in the mud. Buena Vista Lake is today a notable breeding place for ducks of several species. Their nests are placed in grassy and marshy spots in the vicinity of, yet removed from, open water. Runways to and from such sites might readily lead the birds into danger from oil seepages and deprive them of the immunity accorded to gulls and grebes.

Can we derive profit in comparing the McKittrick fauna with that of other lacustrine deposits such as Fossil Lake, Oregon? At this locality there has been worked out one of the most varied faunas thus far recorded from western America. Shufeldt (Journ. Acad. Nat. Sci. Phila., ser. 2, no. 9, 1892, p. 389) catalogued fifty or more of its species in 1892 and several have been added since that time. This interesting fauna includes the following groups: Order Pygopodes, 8 species; Longipennes, 9; Steganopodes, 2; Anseres, 30; Odontoglossae, 1; Herodiones, 3; Paludicolae, 2; Limicolae, 1; Gallinae, 5; Accipitres, 3; Striges, 1; Passeres, 2.

This list is notably lacking in storks, in cranes, and in scavengers, while herons and shore birds are but sparingly present. On the other hand, it is rich in divers, in gulls, and in ducks. The several students who have studied the assemblage of species agree that an open, shallow, and possibly ephemeral lake

constituted the Pleistocene environment that attracted them. Whether subject to complete periodic obliteration or not, it probably did fluctuate greatly in extent within its shallow basin. The fossil remains are found sparsely distributed over a wide area and preserved in the silt-like accumulation at the bottom of the ancient lake. There is no evidence of concentration at one point such as appears at both the asphalt horizons. It hardly seems credible that waders were lacking at Fossil Lake or that gulls and divers shunned the neighborhood of McKittrick during Pleistocene time. The difference between the two avifaunas is more probably due to difference in method of entombment rather than to diversity of physiographic or of climatic environment. Probably the birds actually present during the Pleistocene were much the same in the two localities, although it is likely that there was more marsh and slough country in the neighborhood of McKittrick.

On the other hand, the differences between the McKittrick and the Rancho La Brea collections are due probably to an actual difference in fauna due to diversity of the immediate environments of two localities in which the method of entombment was the same.

Regarding the particular part of the Pleistocene to which the McKittrick assemblage belongs, it is too early yet to comment at any length. The writer has already pointed out (Univ. Calif. Publ., Bull. Dept. Geol., vol. 7, no. 5, 1912, p. 105) the inaccuracy of avian remains as indices to the relative age of two faunas where one of them includes a much larger proportion of migratory species than does the other. Just such diversity of habit sets off the McKittrick assemblage from that of Rancho La Brea. This fact coupled with the poverty of material thus far excavated from the former beds makes comment upon their relative ages at present inadvisable. Both seem, however, to have been accumulated during a time when the climate was warmer than at present, though whether or not during the same Pleistocene amelioration can not be stated.

Los Angeles, California, May 15, 1922.